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FEATURE ARTICLE: WHEN IT'S NOT "BUSINESS-AS-USUAL": IMPLICATIONS FOR ABS TIME SERIES

INTRODUCTION

Sound economic statistics are vital for decision-making. The ABS has a key role in producing high quality statistical information to assist with policy- and decision-making at all levels of government and in the community more broadly. One of the most useful types of economic statistics produced by the ABS is its time series information: a collection of observations of well-defined data items obtained through repeated measurements over time. The examination of time series can allow a data user to monitor phenomena over time and identify changes to series which may be associated with external events of interest. In particular, the ABS removes systematic calendar related effects from original estimates (or raw data) to produce seasonally adjusted and trend estimates. These are published as additional analytical products to help users to understand time series signals.

In recent months, a range of government interventions, designed to mitigate or offset the consequences of the global financial crisis, have been implemented in Australia. These interventions have been detected in a range of ABS time series, including Labour Force and Retail Trade. To appropriately reflect the global economic crisis in ABS time series data, and hence, to ensure the accuracy of time series analytical products produced by the ABS, a number of methodological decisions are required. These decisions (discussed later) will allow users to appropriately interpret affected time series data.

This article reviews the implications of unusual external events on ABS time series (i.e. when it's not 'business-as-usual' in the economy). It also discusses the principles and issues involved in making methodological decisions regarding the appropriate treatment of time series in these circumstances. A case study of the ABS Retail Trade time series, which has exhibited changed characteristics in the presence of the current unusual economic environment, will be used to illustrate the issues involved in maintaining a high quality seasonal adjustment.

TIME SERIES DATA AND THE DIFFERENCES BETWEEN THE ORIGINAL, SEASONALLY ADJUSTED AND TREND ESTIMATES

Typically, the ABS decomposes an observed, original time series into three components: the trend (general direction of the series), the seasonal component (systematic, calendar related movements) and the irregular component (unsystematic, short term fluctuations). Seasonal influences tend to occur regularly once or more each year, and include the effect of periodic factors such as weather, holidays, social conventions, administrative practices, and the composition of the months or quarters into trading days. Seasonally adjusted estimates are produced by estimating the seasonal component and removing this from the original series. Seasonally adjusted estimates therefore reflect the combined effect of the trend and irregular components. The ABS then calculates trend estimates by applying a smoothing procedure to the

seasonally adjusted estimates. Therefore, the seasonally adjusted and trend estimates are **analytical products** rather than raw data.

The ultimate objective of ABS time series techniques is to provide users with two high quality analytical time series indicators that present different but complementary information derived from an original time series, for the purpose of informing decision making. The seasonally adjusted estimates have had seasonal patterns removed, allowing useful information to be portrayed regarding direction and the amount of volatility in the data. Trend estimates, produced by smoothing the seasonally adjusted estimates, provide important information regarding the longer term behaviour of the data. It is important to note that neither the trend nor seasonally adjusted series are inherently of more value or importance than the other.

It is also important to distinguish between the trend **concept**, defined as the mid- and long-term signal in a series, and a trend **estimate**, which is the estimated mid- and long-term signal. It may be analytically difficult to produce a good trend estimate which reflects the trend concept due to a large distortion or outlier in the series, but the trend concept is still appropriate with respect to the mid- and long-term signals in a time series.

DEFINING UNUSUAL EVENTS: THE CASE OF THE GLOBAL ECONOMIC CRISIS

As with any analytical products, the ABS seasonally adjusted and trend estimation methods make certain normality assumptions. The methods used to produce seasonally adjusted and trend estimates are reasonably reliable under 'normal', 'business-as-usual' circumstances. However, unusual real world events, such as the global financial crisis or significant government economic interventions, will affect seasonally adjusted and trend estimates. If an appropriate methodological intervention is not applied to the seasonally adjusted and trend estimation methods on time, or is applied inappropriately, then users may be misled when interpreting the seasonally adjusted and trend estimates.

Unusual events can be grouped into two categories according to their causes: methodological changes (such as changes to classification, scope, coverage etc.); and real world effects (unusual events with significant impact on ABS statistics, such as the global economic crisis). Examples of real world effects include the introduction of Goods and Services Tax in July 2000, which impacted on the Retail Turnover; the 2000 Sydney Olympics Games, which affected Overseas Arrivals and Departures, and the gold sell-off by the Reserve Bank of Australia in 1997, which affected the Exports of Other Goods etc.

In this article, we are focusing specifically on the impact of real world effects on ABS time series, with particular emphasis on the recent and still ongoing global economic crisis and consequent government interventions. In brief, the global economic crisis was marked by a series of international and domestic events, commencing around the September 2007 quarter and continuing to the present time. These events included:

- The US credit crunch and discovery of sub-prime mortgage securities;
- The drying up of liquidity;
- Announcements of bankruptcy of overseas credit providers, with some government intervention to nationalise or acquire large stakes in some companies;
- Falls in domestic and international stock markets;
- Several bank mergers or acquisitions;
- The insolvency announcements in Australia by a range of commercial and financial entities;
- Provision of liquidity facilities by Central banks;
- Government guarantees of bank deposits; and
- Australian Government implementation of a series of varied stimulus packages (December 2008; February 2009 etc.).

These events, and other related events not listed above, have provided a challenge to those producing social/economic indicators including a number of ABS economic time series. The challenge for the ABS is to evaluate and monitor the likely impact of these events on economic time series to determine the most appropriate methodological treatment, if any, in order to produce high quality seasonally adjusted and trend estimates and maintain the ABS' goal of promoting informed interpretation of signals in time series data.

IMPACT OF UNUSUAL EVENTS ON TIME SERIES ANALYTICAL PRODUCTS

Real world impacts on time series analytical products, such as seasonally adjusted and trend estimates, can be minimised if the ABS has reliable information for estimating the statistical impact of the event. However, this information is often unavailable and the ABS therefore has to estimate the extent of the effect using the original series.

The seasonal adjustment procedure used by the ABS is based on the X-11 method developed by the US Bureau of the Census (Shiskin, et al. 1967). With this method, large changes in the original time series (whether temporary or permanent) impact significantly on the seasonal and trend estimation procedures. Consequently, these large changes will affect the seasonally adjusted and trend estimates.

For the **estimation of seasonal factors**, the current seasonal adjustment process is relatively robust as it will discount 'extreme' irregular values so that the seasonal factors are not distorted in the short-term. For example, for series with low volatility, any extreme irregular value larger than 1.5 times the standard deviation (a quantity to measure the spread of the series' volatility over time) will be ignored, and the seasonal adjustment process will treat the occurrence of the extreme irregular as an outlier, replacing it with a more representative value for the purpose of estimating seasonal factors.

Seasonally adjusted estimates are derived by removing the appropriate seasonal factor from the original series. Due to the robustness of the seasonal factor estimation, the accuracy of the seasonally adjusted estimates will generally not be compromised by the occurrence of an extreme irregular. It is important to note, however, this does not mean that they accurately reflect the underlying **long-term** movement of the series, especially when the unusual events have a lasting impact.

Trend estimates are obtained by smoothing the seasonally adjusted estimates, with an assumption that the irregular component is random and normally distributed. Distortion of the trend estimate will occur in the presence of an unusual event, and if no correction for the impact is introduced, then the trend estimate can be misleading.

Unusual events may affect one or more of the three components of a time series. Unusual events may cause a short-term, one-off impact (irregular), a change to the pattern of seasonal variations (seasonality) or a change in the underlying movement of the series (trend). These are briefly discussed here using recent real world examples.

A large, extreme irregular is an uncharacteristic movement in the original estimates. For example, the Sydney Olympics (September 2000) demonstrated a one-off effect on both overseas passengers arrivals and retail trade turnover. In turn, this impact led to a one-off impact on the seasonally adjusted series. If a one-off extreme impact is not corrected, it can distort the trend estimation procedure resulting in misleading information, as the estimated trend may be either deflated or inflated for one or more time points. If information on the magnitude of the impact is available, a correction can be applied to ensure the trend is not distorted. However, this

information is often not available at the time, and at least one or more additional observations are normally required to help assess the impact.

A permanent **change to the seasonal pattern** is referred to as a seasonal break. To reliably assess whether a change in seasonal pattern is permanent, the ABS uses three or more years of data, from the point of the seasonal break. If a change in seasonal pattern is found to be permanent, an appropriate correction is applied, as abrupt changes to the seasonal pattern can adversely affect the reliability of seasonally adjusted and trend estimates. An example of a proposed seasonal break correction could be the introduction of new legislation that affects the timing of tax collections. The consequent breaks in the seasonal factors would be recognised and corrected, but usually only after three years have elapsed.

An abrupt and sustained **change in the level of the series** is referred to as a trend break. When a trend break occurs, the ABS corrects for the permanent shift in trend estimates by either estimating the size of the break or using prior information to determine the size of the break. More commonly, there is insufficient information relating to the size of the trend break at the time of the impact. The ABS therefore has to use the series to estimate, post-hoc, the magnitude of the trend break. At least three observations after the occurrence of the trend break are needed to reliably estimate the magnitude of the break. For example, the introduction of the GST in July 2000 forced the ABS to suspend the publication of trend estimates until November 2000 when more data were available to estimate the impact.

A sequence of unusual events with an unknown quantifiable nature can also occur in reality. Under these circumstances, the ABS has to make a judgment either not to apply any methodological intervention and to provide a warning to our data users indicating the potential impact to our time series analytical products, or to apply appropriate methodological interventions with the best information at the time and avoid misinterpretation of the analytical products. For the latter case, one approach could be to use the projected seasonal factors from the past observations rather than estimating seasonal factors using data up to the most current time point, and suspend the publication of trend estimates. The ABS has to make a sound judgment and balance factors such as timeliness, accuracy and interpretability of its analytical products taking into account the ABS' seven-dimension data quality framework (ABS 2009).

The ABS will provide a revised version of the trend and seasonally adjusted time series when either more information relating to the impact comes to hand or when more observations become available, allowing an appropriate methodological intervention to be applied.

MAKING DECISIONS ABOUT APPROPRIATE TREATMENT OF UNUSUAL EVENTS IN TIME SERIES

Given the range of possible impacts of real world events on time series data outlined above, rigorous qualitative and quantitative assessments and judgment are needed when making decisions about the appropriate methodological treatment of affected time series for seasonally adjusted and trend estimates. In the event of there being impacts on series which are due to unusual real world events, there are four major approaches which can be taken. These are outlined here briefly.

One option for time series analysts is to make no correction to the seasonal adjustment estimation procedure, and to allow trend estimates and seasonal factors to continue their natural course. This approach may be most appropriate when there is very little or no information available to indicate how long an unusual event may persist.

A second option is to make a correction for the extreme estimate after one additional original estimate becomes available. In other words, no correction to the estimation procedure is made at

the time of the occurrence of the unusual event, but a correction is inserted in the next publication of the series.

Third, a trend break correction may be introduced after three or more periods following the occurrence of the unusual event. The trend estimates may not be published in the period prior to introducing such a correction. This approach is currently being used to manage the ABS Retail Trade series which heavily reflects the impacts of the global financial crisis and the government stimulus interventions. As will be discussed in more detail in the following case study, the trend series is currently suspended from this publication pending the collection of additional retail trade data over time to enable the identification of appropriate treatments for trend estimates. If the ABS had continued to publish the trend for these series, the trend series could have provided a misleading signal to users due to the unusual influences on the trend estimation method.

Finally, a seasonal break correction may be introduced after three or more years of additional original estimates become available. Until then, the trend and seasonally adjusted estimates continue to be calculated without methodological intervention.

The choice of approach to be taken when dealing with time series affected by unusual real world events also depends on a number of other factors. These include the measurability of an impact (the estimated size of a known impact in the context of the usual volatility of the indicator series); data frequency (higher frequency time series are generally more greatly impacted by a particular distortion or outlier); different impacts on different parts of the economy (an impact on some ABS indicators may not be observed, or may be observed differently, for other ABS economic indicators); and consistency (the need to consider related indicator time series which have similar underlying concepts when applying treatments or interventions to seasonally adjusted and trend estimates).

CASE STUDY 1: RETAIL TRADE FOLLOWING THE DECEMBER 2008 GOVERNMENT STIMULUS PACKAGE

As mentioned earlier, the impact of the US credit crunch induced by the sub-prime mortgage crisis and the drying up of liquidity started in 2007 and then proceeded to spread around the world. The Australian financial markets and economy were not immune from this crisis, and a notable slowing down of Australian retail turnover has been observed since 2007. To prevent a potential spiral and slowing down of the economy, the Australian Government implemented a \$10.4 billion Economic Security Strategy as a short term cash injection stimulus package to strengthen the Australian economy in the face of the worst global financial crisis since the Great Depression.

For December 2008, the original and seasonally adjusted Retail Trade estimates included consumer spending resulting from payments received by families and pensioners as part of the this package. The full amount of these payments is unlikely to have been spent entirely in December and may have been spent in later months in either the retail or non-retail sectors, or alternatively used to reduce debt or to contribute to savings (which may in turn impact on future spending patterns).

In February, the Australian Government announced a further \$42 billion Nation Building and Jobs Plan to support jobs and invest in future long term economic growth. This included both a short term stimulus package and a series of long term infrastructure projects (Rudd 2009).

As noted previously, ABS trend estimates attempt to measure the underlying behaviour in retail activity. In the short term, the trend measurement may be significantly affected by an unusual influence in the original and seasonally adjusted estimates like that observed since December 2008. If the trend estimates were to be calculated without fully accounting for this unusual

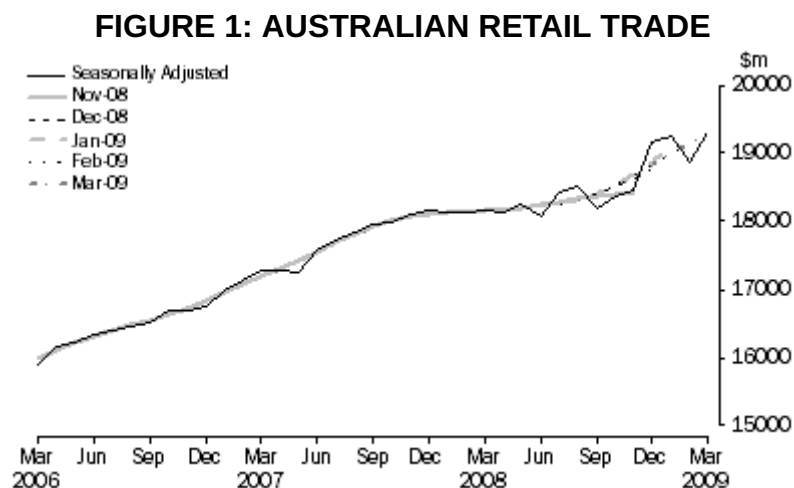
irregular event, they would be likely to provide a misleading view of the underlying trend in retail activity.

Additionally, spending behaviour in subsequent months may also be influenced by the December 2009 and February 2009 stimulus packages and it may be some time before the true underlying behaviour of the data can be accurately estimated. In response, the ABS decided: (1) to use seasonal factors projected from previous data for seasonal adjustment rather than using the original observations up to the current time point to estimate seasonal factors; and (2) to suspend publication of the trend estimate from December 2008 (ABS, 2008) pending the collection of additional Retail Trade original observations to enable the identification of appropriate treatments for trend estimation.

The total Australian Retail Trade and the total Domestic Appliances and Recorded Music sub-group are used to demonstrate the impact of the stimulus packages if no intervention were applied to trend estimates.

Figure 1 shows the seasonally adjusted estimate of total Australian Retail Trade up to March 2009, with scenario trend estimates (calculated using November 2008, December 2008, January 2009, February 2009 and March 2009 as their respective end-points) superimposed. It is evident that retail trade started to slow down from the end of 2007. The trend estimates at the November 2008 time point show a reasonably flat increase in the trend at the time. The first Australian Government stimulus package was implemented in December 2008. As a result, retail spending for December 2008 had its largest increase in seasonally adjusted terms since 2000. If no methodological intervention had been applied, the trend estimates of the December 2008 time point would have been distorted, artificially lifting the trend estimates from August 2008 onwards. Obviously, this does not truly reflect the economic reality at that time. It appears that the first Australian Government stimulus package had a profound impact on retail trade in December 2008, and again in January 2009. A lower retail trade observation in February 2009 can be potentially attributed to the short term cash injection running out of strength.

As a consequence of the second government stimulus package announced in February 2009, the retail trade observations again started to grow. From this example, we can see that the retail trade seasonally adjusted estimates appeared to reflect consumer reactions to the government stimulus packages. Since trend estimates are designed to reveal the longer term underlying movement of a series, there is not enough information from the last few months' observations to estimate the potential profound long term impact to the retail trade trend direction, although short-term variations induced by the stimulus packages were observed.

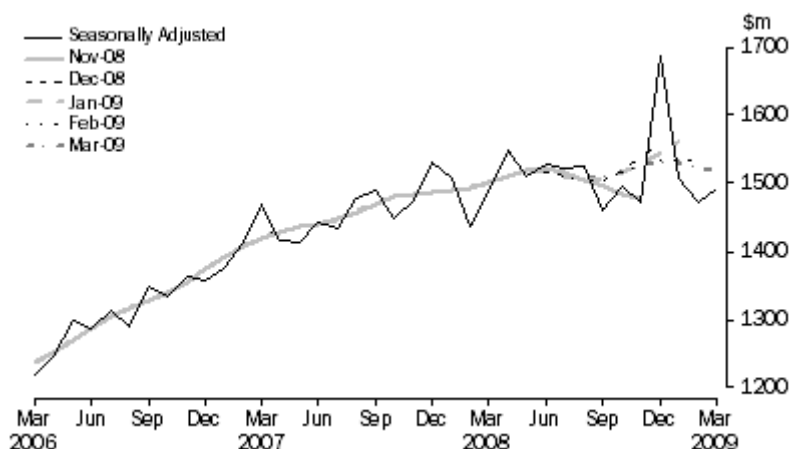


We now turn to examining the most affected retail sub-group, which is Domestic Appliances and

Recorded Music. Consumers appeared to take advantage of the cash injection stimulus package to purchase popular domestic appliances like large plasma/LCD TV, air conditioners and computers.

Figure 2 shows the seasonally adjusted estimates of the Domestic Appliances and Recorded Music Retailing sub-group, with the scenario trend estimates superimposed (as in Figure 1). A large peak at December 2008 reflects the consumer response to the Government's first stimulus package following a decrease in sales since July 2008. The November 2008 trend scenario illustrates clearly the decreasing trend over the five previous months. However, without appropriate methodological intervention, the December 2008 trend scenario shows the increasing trend since September 2008 and potential large increase after December 2008. These estimates obviously provide a misleading picture of reality in later 2008 and give a potentially wrong signal for the future. The consequent trend estimate revisions after December 2008 also show that the December 2008 time point trend estimates are misleading.

FIGURE 2: DOMESTIC APPLIANCES AND RECORDED MUSIC RETAILING



To avoid giving policy decision makers, economic analysts and the general public misleading long term signals in the original estimates at the time, ABS decided to suspend publication of the Retail Trade trend estimates until more data become available to support appropriate methodological intervention and to produce accurate trend estimates.

FURTHER INFORMATION

This article has sought to review the impact on ABS time series when 'business-as-usual' economic conditions do not prevail.

Readers seeking to obtain more information about methodological issues associated with ABS time series are welcome to contact the ABS' Methodology and Data Management Division at methodology@abs.gov.au or by telephone via the National Information and Referral Service on 1300 135 070.

Interested readers are also referred to the ABS publication, **Time Series Analysis Frequently Asked Questions** (cat. no. 1346.0.55.002) which can be found on the ABS website www.abs.gov.au.

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